# A NEW SPECIES OF *BRUGGMANNIELLA* (DIPTERA: CECIDOMYIIDAE) ABORTING YOUNG FRUIT OF AVOCADO, *PERSEA AMERICANA* (LAURACEAE), IN COLOMBIA AND COSTA RICA

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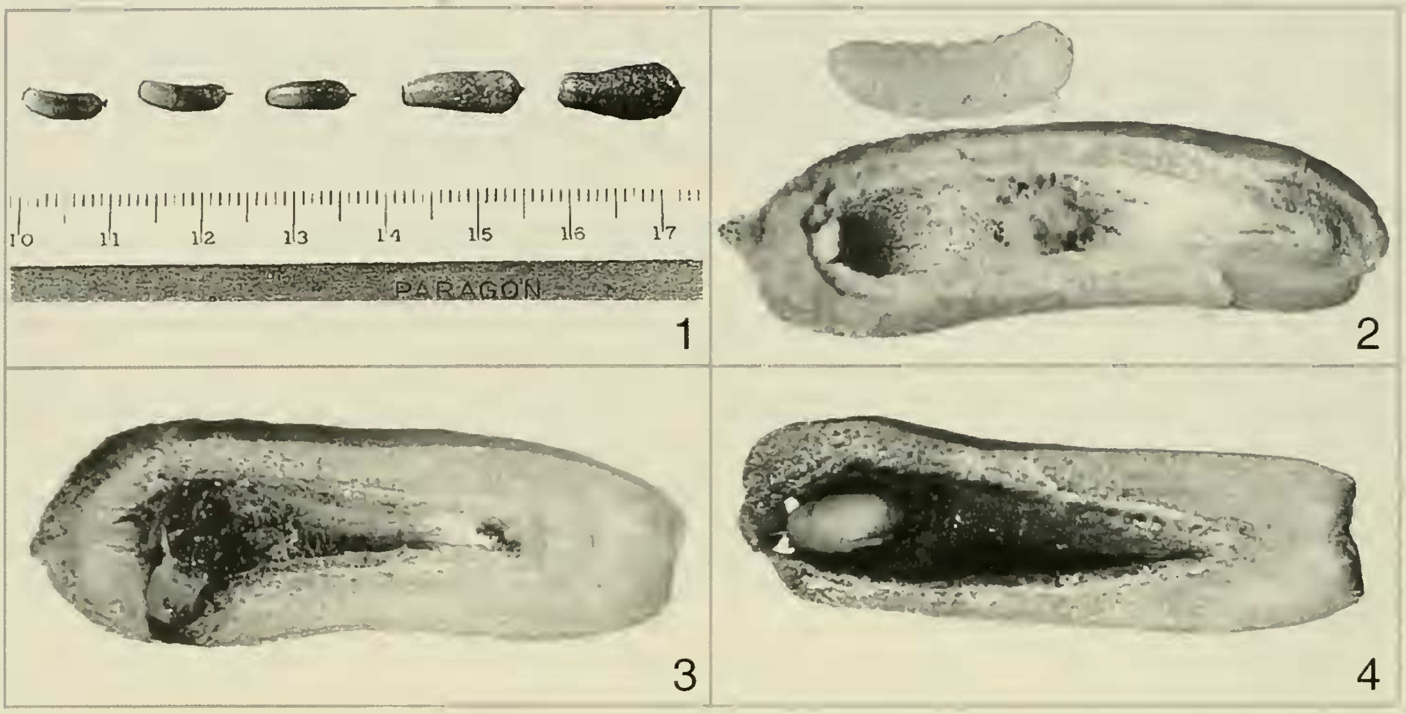
*Abstract.*—A species new to science, ***Bruggmanniella perseae*** **Gagné** (Cecidomyiidae: Diptera), is reported from avocado, *Persea americana*, from Colombia and Costa Rica. The insect is a severe pest of avocado. Infested fruit drop to the soil when less than 2 cm in length. The new species is described, illustrated, and compared with the five previously described species of *Bruggmanniella*, and its biology is outlined. A key to the six species of *Bruggmanniella* is provided.

Key Words: *Persea americana*, avocado, Lauraceae, Neotropical, gall midges.

Avocados, *Persea americana* Miller (Lauraceae), are grown throughout the American tropics and in many places constitute an important part of the agricultural economy. A gall midge (Diptera: Cecidomyiidae) new to science was recently discovered in a coffee growing area in Caldas, Colombia during a survey of insects attacking avocado and also in Carrizal, Costa Rica. Larvae live in ovaries of young fruit and pupate in situ. Infested young fruit, less than 2 cm long (Figs. 1–4), die and dehisce shortly after adult emergence. The new species belongs to the genus *Bruggmanniella* Tavares and is the first record of a gall midge from avocado. It is the sixth species known for the genus. *Bruggmanniella* is Neotropical except for one species that occurs also in southern USA. All six species are specific to a particular plant host, each of a different plant family, as summarized in the key presented in this paper.

## Materials and Methods

Recently fallen young avocado fruit of abnormal shape found in an avocado plantation, Finca Guamal, in Villamaria, near Caldas, Colombia were collected and brought to the laboratory for dissection and observation of contents and life history of the cecidomyiid. To obtain adults, fruit with pupae were placed in glass containers with paper tissues inside to collect excess moisture and prevent the fruit from spoiling. Damaged fruit were also collected in Carrizal, Costa Rica and specimens were obtained in a similar way. Specimens of immature stages and adults were preserved in 70% isopropyl alcohol and sent to the Systematic Entomology Laboratory for identi-




Figs. 1–4. 1, Young avocados of similar age, the three cucumber-shaped fruit on left infested by the cecidomyiid, the two on right normal (scale in cm). 2–4, Longitudinal sections of infested fruit. 2, Full-grown larva removed, showing white fungal lining in fruit. 3, Pupa (damaged) at apex of fruit showing scraped out cylindrical escape tunnel, the exocarp still intact, and the fungus turning black. 4, Fully developed pupa leaving ovoid cell formed of scrapings from escape tunnel and fungal excrescence, the circular exit hole through fruit integument partially visible.

fication. Some samples were mounted on microscope slides using the method outlined in Gagné (1989, 1994). Some pupae and larvae were dried and placed on stubs for scanning electron microscope study. Terminology for adult morphology follows usage in McAlpine et al. (1981) and for larval morphology that in Gagné (1989). Most of the specimens and information on biology were obtained by FP and ZNG. The taxonomic investigation in this paper was the responsibility of RJG.

## Diagnosis of *Bruggmanniella*

*Bruggmanniella* species are easily separated from those of the generally similar *Asphondylia* Loew by characters found in males and pupae (Gagné 1994). The male genitalia of *Asphondylia* have a wide, apical gonostylar tooth and lack parameres, while the genitalia of *Bruggmanniella* have two small, separate gonostylar teeth and parameres. Pupae of the two genera differ substantially: the integument is unpigmented in *Bruggmanniella*, except for the brown antennal horns and prothoracic spiracles, but is entirely brown to black in *Asphondylia*; the frons of *Bruggmanniella* lacks the prominent horns found in *Asphondylia*; the abdomen of *Bruggmanniella* has tiny, closely-set abdominal tergal spicules and some spinelike abdominal spiracles instead of large, discrete tergal spines and entirely sessile spiracles found in *Asphondylia*.

Several characters not used in the key that follows may be diagnostic for separating *Bruggmanniella* species but have not been described for some or all previously described species. Two such characters are the length of the needlelike part of the ovipositor in relation to that of the seventh sternite and the number of spiniform spiracles of the pupal abdomen. In the new species, the needlelike part of the ovipositor is 2.9–3.2 times the length of the seventh sternite, while in *B. bumeliae* (Felt), the only other *Bruggmanniella* species we have seen, the needlelike part is only about 2.0 times as long as the seventh sternite. In *B.*

*maytenuse* (Maia and Couri) the ratio has been reported as 2.7 and in *B. byrsonimae* (Maia and Couri) as 4.0 (Maia et al. 1992). The pupa of the new species has five pairs of spiniform abdominal spiracles while *B. bumeliae* has six. In the key to species that follows, we have supplied host, distribution, and helpful references.

### Key to Pupae and Third Instar Larvae of *Bruggmanniella* Species

1. Larval spatula with 4 apical teeth (as in Fig. 12); pupal antennal horn in ventral view acutely triangular, narrowed gradually from base to pointed apex (as in Fig. 14) . . . . . . . . . . . . 2
– Larval spatula with 3 apical teeth (as in Fig. 13); pupal antennal horn in ventral view narrowed abruptly at midlength (as in Fig. 11) 5
2. Pupal antennal horn minutely serrate laterally (as in Fig. 14) . . . . . . . . . . . . . . . . . . . . . 3
– Pupal antennal horn coarsely serrate laterally . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4
3. Pupal antennal horn concave laterally (Fig. 14); ex young fruit of *Persea americana* (Lauraceae), Colombia and Costa Rica . . . . . . . . . . . . . . . . . . . . . . . . . *B. perseae*, new species
– Pupal antennal horn convex laterally; ex fruit of *Maytenus obtusifolia* (Celastraceae), Brazil . . . . . . . . . . . . . . . . . . . . . . . . . . *B. maytenuse* (Maia & Couri) (Maia 1999, Maia et al. 1992)
4. Pupal antennal horn straight laterally except for serrations; ex multichambered, swollen stem apices of *Sorocea ilicicola* (Moraceae), Brazil . . . . . . . . . *B. braziliensis* Tavares (Möhn 1963)
– Pupal antennal horn convex laterally; ex single or mutichambered, swollen buds of *Byrsonima sericea* (Malpighiaceae), Brazil . . *B. byrsonimae* (Maia & Couri) (Maia et al. 1992, Maia 2001)
5. Pupal antennal horns twice as long as widest diameter (Fig. 11); ex multichambered twig galls of *Bumelia lanuginosa* (Sapotaceae), USA (southern), Mexico . . . . . . . . . . . . . . . . . . . . . . . . . . *B. bumeliae* (Felt) (Gagné 1994)
– Pupal antennal horns approximately as long as widest diameter; ex multichambered galls on stems of *Schinus* sp. (Anacardiaceae) Brazil . . . . . . . . . . . . . *B. oblita* Tavares (Möhn 1961)

## *Bruggmanniella perseae* Gagné, new species

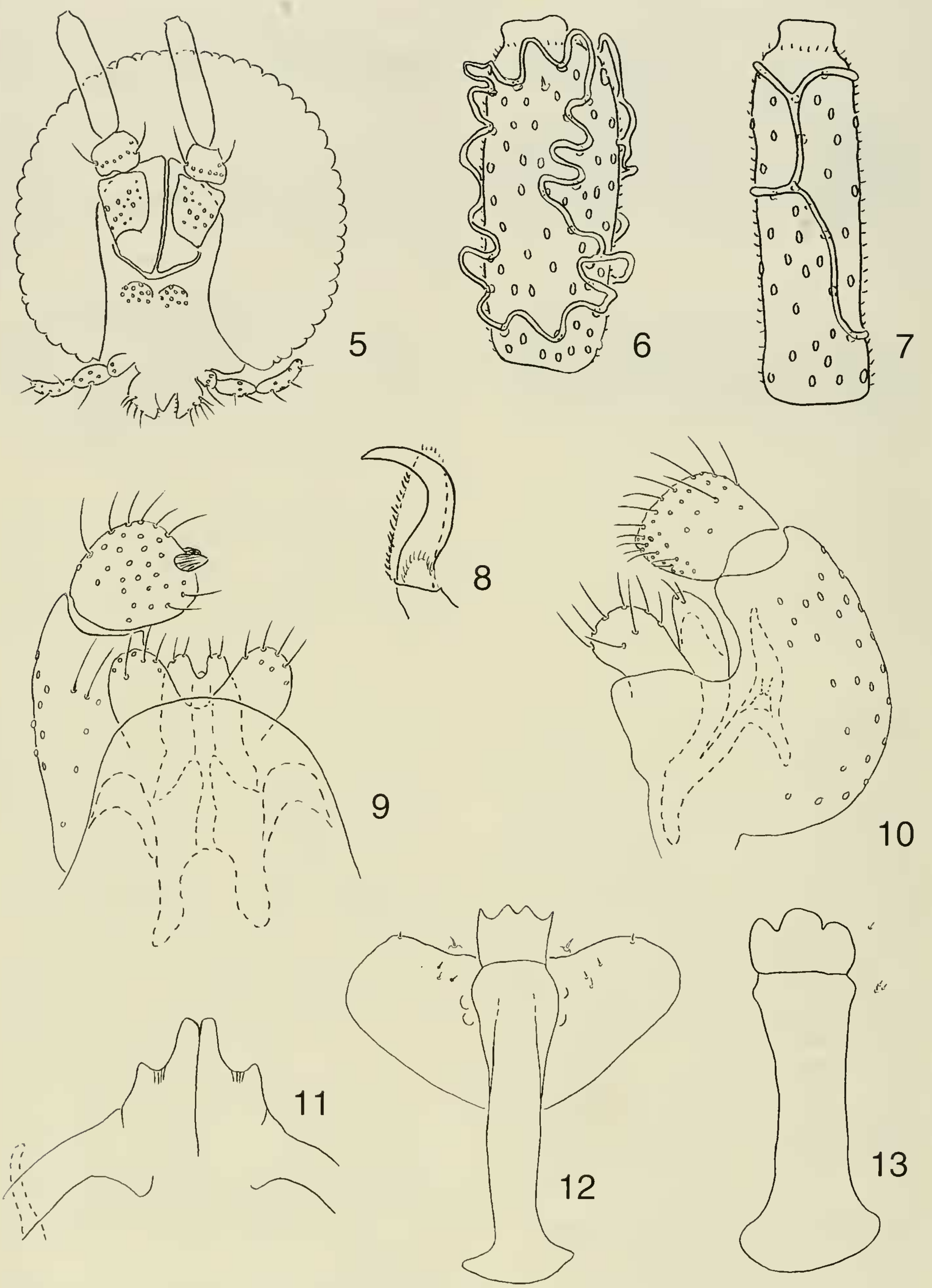
(Figs. 5–10, 12, 14–18)

Adult.–*Head* (Fig. 5): Eye connate, 8–9 facets long at vertex; facets hexagonal, all closely approximated. Frons with 8–15 setae per side. Clypeus with apicodorsal row of 4–5 short setae. Labellum with 5–7 setae laterally and patch of short setae mesally. Palpus 3 segmented, first segment about as long as wide, second segment broadest, about twice as long as wide, third segment 2–3 times as long as wide, all with scattered setae and covered with setulae. Antenna: Scape cylindrical, ca. 1.5 times length of pedicel; pedicel globular, slightly wider than long; first and second flagellomeres partially connate; male flagellomeres (Fig. 6) each with four wavy circumfila running along flagellomere length and connected near base and near apex of flagellomere; female flagellomeres (Fig. 7) with two circumfila running along length and connected to one another at base and apex.

*Thorax:* Wing length, male 2.4–3.1 mm (n = 5), female 2.5–3.0 (n = 7). Dorsocentral setal row at midlength 3 rows broad, rows continuing onto scutellum to posterior margin, scutellum otherwise bare. Anepisternum with several setae clustered in middle. Anepimeron covered with setae. Katepimeron bare. Acropods (Fig. 8): Tarsal claws subequal in size and similar in shape on all legs; empodia as long as bend in claws; pulvilli about ¼ length of empodia.

*Male abdomen:* First through seventh tergites: rectangular with mostly single row of posterior setae, except seventh tergite with mostly 3 rows of posterior setae; several lateral setae present, more numerous on seventh tergite; elsewhere covered with scales; with anterior pair of trichoid sensilla, not easily seen because not much larger than and situated among anteriormost scales. Eighth tergite unsclerotized, without vestiture except for anterior pair of trichoid sensilla. Sternites covered with setae and scales, without anterior pair of trichoid sensilla, male eighth sternite greatly reduced in size, twice as wide as long. Genitalia as in Figs. 9–10.

*Female abdomen:* First through seventh tergites as for male. Eighth tergite diminutive, bare, the only vestiture the anterior pair of trichoid sensilla. A pair of large lobes present immediately posterior to




Figs. 5–13. 5–10, *Bruggmanniella perseae*. 5, Head, frontal. 6, Male third flagellomere. 7, Female third flagellomere. 8, Tarsal claw, empodium, and pulvillus. 9, Male genitalia, one gonopod removed, dorsal. 10, Same, lateral. 11, *Bruggmanniella bumeliae*, antennal horns and prothoracic spiracle, ventral. 12, *B. perseae*, larval spatula and associated papillae. 13. *B. bumeliae*, same.

eighth tergite, entirely covered with large, spiny, mostly recurved setulae. Sternites covered with setae and scales, without anterior pair of trichoid sensilla, seventh sternite about 2.3 length of preceding sternite. Basal half of ovipositor evenly cylindrical, with longitudinal rows of setulae, distal half of ovipositor rigid, needlelike, 2.9–3.2 (n = 5) times as long as seventh sternite.

Pupa (Figs. 14–16).—Integument unpigmented except for dark brown antennal horns and prothoracic spiracle. Antennal horns elongate, dorsoventrally flattened, in dorsal view widest and parallel-sided at base, distal two-thirds scalloped laterally and gradually narrowing to acute apex, entire length covered with shallow striae, and scalloped edge minutely serrate. Frons convex, without prominences, with 0–2 papillae near each palpal base, each with short seta. Clypeus with 0–2 papillae, each with seta. Pair of vertexal papillae with elongate setae. Prothoracic spiracles elongate. Abdominal spiracles of first and eighth segments sessile, those of second through sixth segments elongate-spiniform. Abdominal tergites with anterior pair of papillae, each with short seta, second through seventh tergites with several rows of many, closely spaced spicules, four dorsal papillae with setae, two each situated at lateral third of posteriormost spicule row. Eighth tergite with field of spicules nearly divided mesally into two groups and much less numerous, shorter, and more robust than on seventh tergite. Abdominal segments otherwise uniformly minutely spiculose.

Third instar larva (Figs. 12, 17–18).—Yellow. Spatula with 4 prominent anterior teeth, lateral teeth more acute and usually slightly shorter than mesal teeth. Three lateral papillae present on each side of spatula, all setose. Sternal papillae setose. Dorsal and pleural papillae with short setae. Terminal segment papillose, blunt, papillae not distinguishable from spicules.

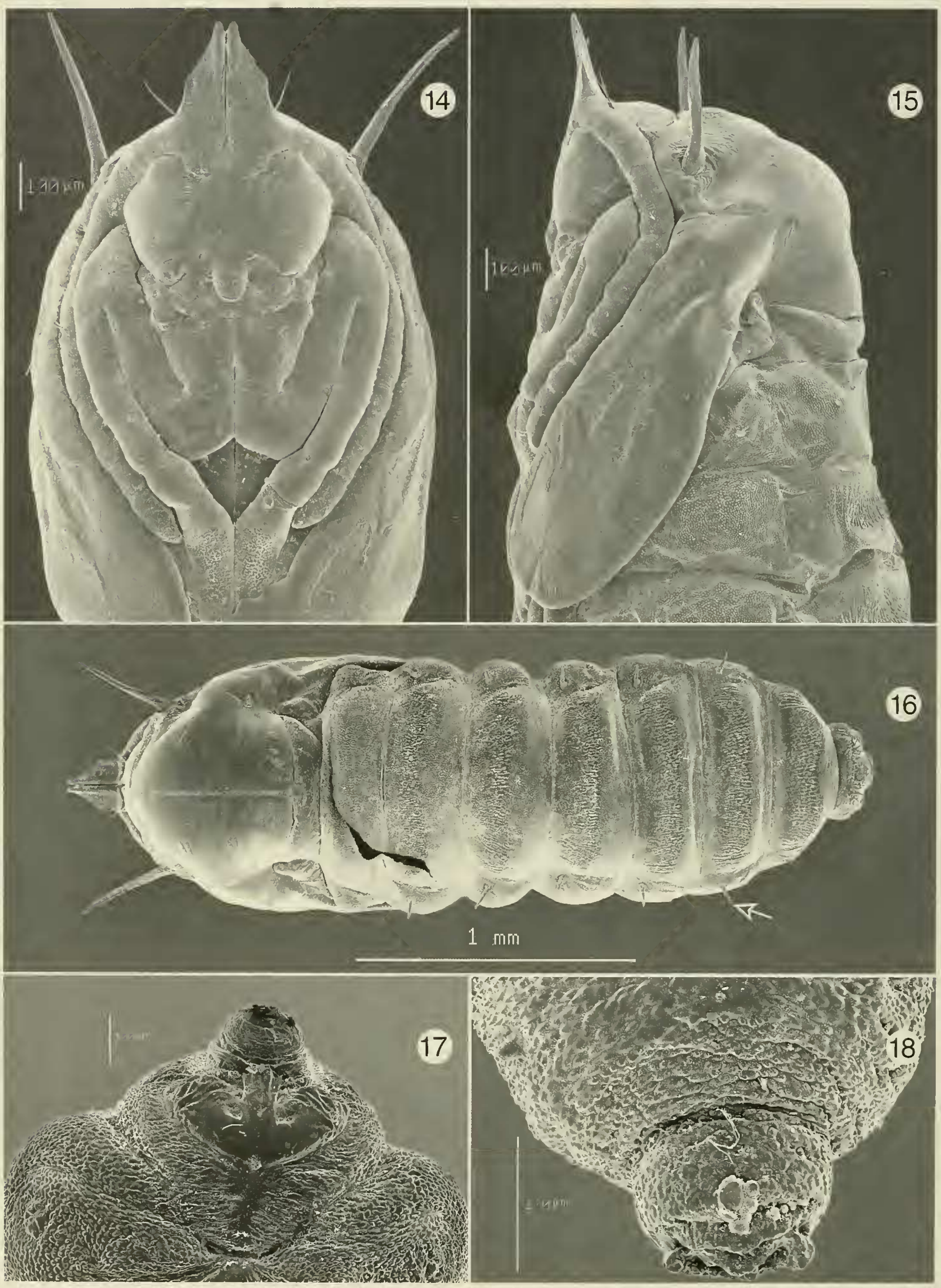
Holotype.—Male, from fruit of *Persea americana*, Villamaria, Caldas, Colombia, III-1999, F. Posada & Z. Gil, deposited in Cenicafé Insect Collection, Chinchiná, Caldas, Colombia.

Other material examined.—2 ♂, 4 ♀, 11 pupae, 7 larvae, same data as holotype; 1 ♂, 3 ♀, 2 pupae, 5 larvae, same data as holotype except III-2002; 1 ♂, 2 larvae, Carrizal, Alajuela, Costa Rica, 11-IV-2002, A. Gonzalez & P. Hanson. All deposited in National Museum of Natural History, Washington, DC.

Etymology.—The specific name means "of *Persea*." We suggest for a common name, the avocado ovary gall midge.

Remarks.—This species differs from all other known species of *Bruggmanniella* by the unique shape of the pupal antennal horns. It also differs from other species by the other characters used in the key, and presumably in other characters as well but which have not yet been described for all other species. The only other species known from fruit is *B. maytenuse* and, interestingly, it and the new species exit at the same couplet in the key to species. The needlelike half of the ovipositor of *B. perseae* is 2.9–3.2 times the length of the seventh sternite, while in *B. maytenuse*, as mentioned earlier, it is only 2.7 times as long (Maia et al. 1992). This ratio appears to be useful to distinguish *Bruggmanniella* species, but users should be cautioned that slide mounted specimens are not always properly displayed, with the ovipositor not always completely flat or straight. The terminal papillae of *B. perseae* larvae are indistinguishable from surrounding tissue but in *B. maytenuse* they each bear a very noticable seta (Maia 1999).

Biological notes.—The female of *B. perseae* inserts a single egg in the ovary of each flower it attacks. Upon hatching the larva feeds with its head towards the pedicel end of the ovary, while the fruit extends beyond the larva into a cucumber-shaped cylinder with an elongate chamber that during the course of larval feeding becomes partially filled with white hyphae of a presumably symbiotic fungus. An infested fruit can be recognized in the field by its shape when only about 1 cm long (Fig. 1). Nor-




Figs. 14–18. *Bruggmanniella perseae* pupae and larvae. 14, Anterior half of pupa, ventral. 15, Same, lateral. 16, Pupa, dorsal, with arrow pointing to spiniform spiracle. 17, Larval head to second thoracic segment showing spatula in center, ventral. 18, Larval eighth and terminal abdominal segments, dorsal.

mal fruit are pyriform at that length, but infested fruit instead become elongate and slender, cucumber-like. When the larva is full grown (Fig. 2), it turns head to tail and migrates towards the apical end of the fruit. By means of its spatula (Fig. 17), armature present in the third instar larva of most gall midges, the larva scrapes away an exit tunnel partway through one side just anterior to the apex and extending only to the thin exocarp wall (Fig. 3). The larva retreats to the main chamber and pupates immediately, nestled in the particulate matter from the scraping mixed with the fungus, which turns black and brittle after cessation of larval feeding. A short time later when the adult is fully formed inside the pupa and by which time the uncut circle of exocarp has turned brown, the pupa advances head first through the exit chamber and cuts a circular opening to the outside by gaining purchase inside the tunnel with the help of its abdominal tergal spicules and applying its pupal horns to the uncut end of the tunnel while rotating its body around the longitudinal axis (Fig. 4). The pupa then exits partway and the adult emerges from the end of the pupal body. Shortly afterwards, still less than 2 cm in length, the aborted fruit drops to the soil.

Many galls contained a parasitoid belonging to the Eulophidae (Hymenoptera). The parasitoid kills the cecidomyiid before the latter pupates, so must form its own escape hole, usually through the very apex of the fruit. The hymenopteran is the subject of a separate paper in preparation by Paul E. Hansen and Alan Gonzalez of the Escuela de Biología, Universidad de Costa Rica.

Infested fruit could be found throughout the year. In 1999 in varieties such as Pinochet and Edranal in Finca Guamal near Caldas, Colombia, the insect appeared responsible for 100% fruit drop. No evaluation was carried out to determine if the lack of fruit set was a result of fly attack or other factors also. In Costa Rica, the infestation is more seasonal and there appears to be only one generation of the gall midge per year.

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